into one continuous chain, some three thousand miles of terminal moraine. If this comprehensive view had been possible to some geologist twenty years ago, how different might be the literature of our drift!

IMPROVEMENT OF THE NATIVE PASTURE-LANDS OF THE FAR WEST.

It is a well-known fact, that the greater part of the United States west of the meridian of Omaha is unfit for tillage. Here and there, there are strips of land, which have a larger rainfall, that may be brought under the plough; and along the rivers there are narrow belts of land that may be made tillable by irrigation. A portion of this region is utterly barren; but a large part of it — probably not far from one million square miles of the whole area, or an area nearly one hundred times the surface of Massachusetts — bears a scanty crop of grasses. The natural use of this region is already recognized: its sole worth is for the pasturage of cattle and sheep. Already a great herding industry has been created in this region, — one that has an important bearing on the food-supply of this country and of Europe. The only limitation on the great extension of this industry is found in the scantiness of the herbage and the inadequacy of the water-supply. The latter evil is probably remediable, in most cases at least, by wells or by storage-reservoirs, which shall retain the abundant waterfall of the rainy season. I propose to offer some suggestions concerning the possibility of bettering the herbage of forage-plants.

All the grasses that now grow in that region make but a scanty herbage. I am informed by stock-raisers, that the best 'ranges' require from fifteen to twenty acres to a head of horned cattle, and that from this unusual goodness the 'ranges' decline in value, until, in many districts, a hundred acres is required to supply a beast. The wide extent of the ranges necessary to afford pasturage to herds of profitable numbers makes the supply of water more difficult than it otherwise would be.

It seems to me possible that the pasturage of this region might be materially improved by the introduction of grasses and other forage-plants indigenous to regions having something like the same conditions of climate. My reasons for hope in this matter are substantially as follows: the experience of settlement in this country shows that the grasses are more easily feralized than any other of our domesticated plants; several of them show a willingness to escape to the wilderness; so that there is hope that a careful selection in various lands might afford some other species that would run wild on our dry plains and mountains. European experiments in naturalizing grasses have been fairly successful, as in the case of grasses to protect dunes from the action of the wind.

There are many regions in the world where grasses have developed to suit just such conditions as we have on our plains; and in some of those regions the period for the process of development to go on has been far longer than in North America. In North America it has been but a single geological period since the vegetation of the plains and Rocky Mountains was well watered; while in Australia it seems likely that the dryness of the climate has been in existence from a rather remote past. The same is probably the case in the northern parts of Asia and in South Africa. Good effects from the introduction of foreign forage-plants may be hoped for, if the only result were an increase in the variety of the herbage on the plains. With the poorest grasses there are generally wide interspaces between the tussocks of high-growing species. If these intervals could be filled with other forage-plants, the consequence would be a greater amount of food to the acre.

In the effort to naturalize foreign species of forage-plants, attention should be paid to all forms of plants that can afford pasturage or browsing. There are many forms that would be likely to do well along the streams, that might not succeed so well in the open country.

The regions that are likely to furnish plants calculated to flourish in a region of low rainfall include a large part of the earth's surface. Those that would succeed in Dakota are not likely to do well in Texas or Arizona. For the northern region, the uplands of northern Asia or of Patagonia are the most promising fields of search; while, for the middle and southern fields, the valley of the La Plata, southern Africa, Australia, and the Algerian district, may be looked to for suitable species.

The experiment is naturally one for the federal government to undertake, but it need not be costly. Three experimental stations — one in the northern part of Nebraska, one in Texas, and one in Arizona — would serve the needs of a thorough trial. Ten thousand dollars per annum at each station should meet all the expenses of a sufficient trial; at least, until it was proven that the experiment would be successful. If we add the expenses of a travelling student of wild forage-plants (perhaps

another five thousand dollars), we would have a sufficient basis for practical work. If the result should be to increase by only one-tenth the beast-maintaining power of our wild lands, the effort would be worth many millions per annum to the nation. When we consider that the introduction of the species of Poa which receive the name of 'blue-grass' has manifolded the pasturage-value of the regions where it flourishes, it is evident that the project is worth consideration. N. S. SHALER.

HISTORY OF THE APPLICATION OF THE ELECTRIC LIGHT TO LIGHTING THE COASTS OF FRANCE.[1]

III.

As the electric installation at the Planier lighthouse is the newest and most complete, some further details of its arrangement will be of interest. The plan (Fig. 7) shows clearly the position of the two generators, and of the transmission-shafting which sets them in motion.

Both generators are placed upon the same masonry foundation, and their axes are in the same line. In order, however, that one may be ready to replace the other in case of accident, their shafts are keyed together; and they both turn, the one with an open, the other with a closed circuit. Between the two machines is a short column (shown in Figs. 9 and 10), which supports the guides for changing the belts from the loose to the fixed pulleys.

Each machine is divided into two circuits, shown by four terminals placed at the upper part of the frame, two at each end. The two

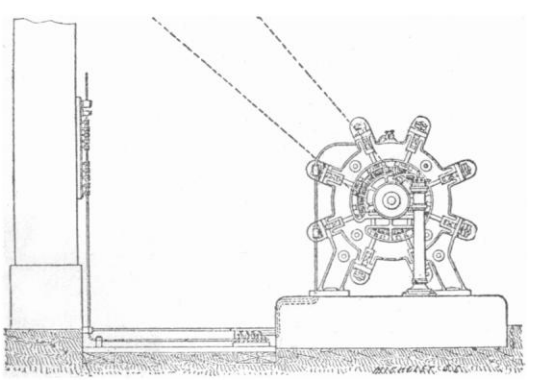

FIG. 9.

terminals placed beside each other at each end of the machine are those which at a given instant form poles of the same name. From each of them is led a copper conductor to the foot of the machine; thence, along the masonry foundation, it follows the ground (as shown in Figs. 9 and 10), and arrives at a commutator

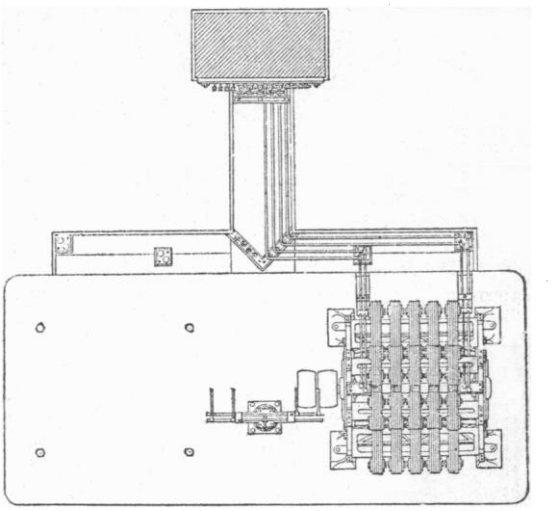

FIG. 10.

placed on the masonry column, which forms one support of the shafting. One object of the commutator is to take the current at will from either machine; another is to couple, either in tension or quantity, the two circuits of each machine. The four possible combinations of the commutator are shown in Fig. 11. An examination of this figure shows that the apparatus consists of fixed and movable contacts arranged in a circle. The first are fourteen in number. The four on the left are in relation with the terminals 1, 2, 3, 4, from which are led the conductors of the machine on the left, or machine No. 1. The four on the right are connected with the terminals corresponding with the conductors of machine No. 2. The three upper contact pieces are attached to the terminals communicating with the conductors of the lamp.

It should be said, that the current reaches the lamp by a large cable, then, after traversing the arc, is divided between two smaller cables, in one of which is placed the electro-magnet of the lamp. Of the three upper contacts, that of the left communicates with the terminal E, to which is connected the cable of the electro-magnet just mentioned; the next belongs to the terminal P C, of the second small cable; finally, the right contact, twice as large as the others, is in communication with terminal G C, of the large cable. This system of fixed contacts is completed below by three pieces,

[1] Continued from No. 6.